ASTR240: Radio Astronomy

HW#2

Due Feb 13, 2013

Problem 1

(Courtesy J. Moran)
At millimeter and centimeter wavelengths, most extragalactic radio sources are time-variable and cannot be used reliably as calibrators. However, planets can be good sources for calibration purposes.

A) Mars has a brightness temperature of about 230 K (uniform over its disk) over this wavelength range. Is this reasonable, assuming Mars has no internal heat sources, i.e., its surface is in radiation equilibrium with the sun ($T = 5800$ K)?

B) What is the flux density of Mars at λ=0.87 mm wavelength on February 13, 2013? You can find the angular size of Mars on the SMA Observer Center website (sma1.sma.hawaii.edu; choose "Tools" and "planetary visibility function calculator").

C) Assume that we observe Mars with one of the 6 m diameter SMA antennas at 0.87 mm. What would the antenna temperature be for the point source approximation?

Problem 2

We will be using an IBT (Itty-Bitty Telescope) to explore the 12 GHz sky around the Wesleyan campus. The telescope has a diameter of $\sim$1 m (slightly less). Please estimate the antenna temperature of the following celestial or terrestrial objects, and rank them from highest to lowest. (Consider whether this is what you would expect observing the same objects with an optical telescope.) Are there other objects in the sky that you might expect to be bright at 12 GHz?

- The Cosmic Microwave Background
- The Sun
- A nearby star
- The Crab Nebula supernova remnant, which has a flux of $\sim$500 Jy at 12 GHz, and a size of 7$\times$5 arcmin.
- A bright quasar (check http://www.vla.nrao.edu/astro/calib/manual/baars.html)

- The planet Saturn (assume radiation equilibrium as in Problem 1)
- VVO (assume we are observing from the parking lot)
- Your fist, held right in front of the dish
- Your hand, held right in front of the dish
- An unladen European swallow flying 10m overhead